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Measurement of Blood Pressure

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Blood pressure is symptomatic of a circulatory system, it is indeed the pressure differentials which dictate the movement of blood throughout the body, its distribution, and velocity. Blood pressure, however, influences far more than mere fluid dynamics - it is intimately involved in vascular permeability, renal function, and even human reproduction.

The measurement of blood pressure is hence a key physical assessment which may shed light upon not only the pressure management of the cardiovascular system, but upon the overall condition of the cardiovascular and other systems.

It is an unfortunate consequence of the pressure upon a medical laboratory that there is seldom time for protruded studies and repeated measurements. Demands for high throughput of patients mean that in many cases the available instrumentation is not utilised to its maximum accuracy (Gabe,I.T).

The basic principle of any device for measuring blood pressure is that the said device must transduce a physical signal into some form of analogue or digital signal. The nature of blood pressure itself, however, is not stable, and contains a complex periodic waveform.

Where the only pressure of interest is some form of a mean pressure, the gold standard is the use of a mercury manometer, such as employed within most general practitioner's surgeries. The important parameters for such a device are that there should be a low baseline drift (change in accuracy over time, commonly due to temperature), and a low hysterisis (decrease in response per increase in signal with higher signal levels).

Dynamic systems provide a much more complex challenge for pressure measurement. In these systems the priorities shift to incorporate response time and temporal resolution. The input signal contains rapid changes in gradient, as well as a large dynamic range, for this reason a rapid rate of response is required.

Fourier theory provides that a periodic function may be broken down into a summation of some set of sinusoidal waveforms. The same analysis may be performed for the periodic function of the heart beat. It has been reported (Gabe, I.T.) that signal above the 10th harmonic may be disregarded as it is insignificant. This provides a practical limitation upon the required accuracy of measurement.

It is to be remembered that working with derivatives of the pressure signal may accentuate higher frequency components, requiring a larger bandwidth for effective processing.

The bandwidth is the range of frequencies above the base frequency which are included. It has been suggested to fit half a cos squared trace to the beginning of a pulse and to then use a bandwidth equivalent to half the reciprocal of the trace width.

References

Gabe, I.T Pressure Measurement in Experimental Physiology Chapter 2, pp 11-50 Cardiovascular Fluid Dynamics, ed. Burgel, D.H, Academic Press, London 1972